# Science & Applications Traceability Matrix (SATM)

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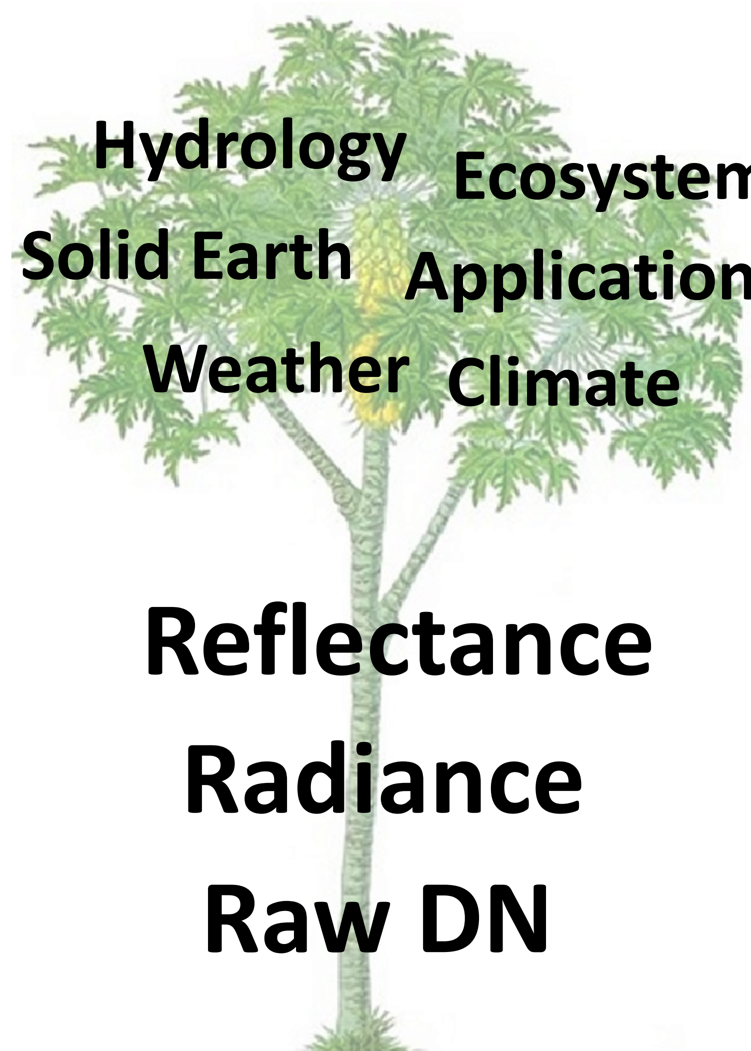


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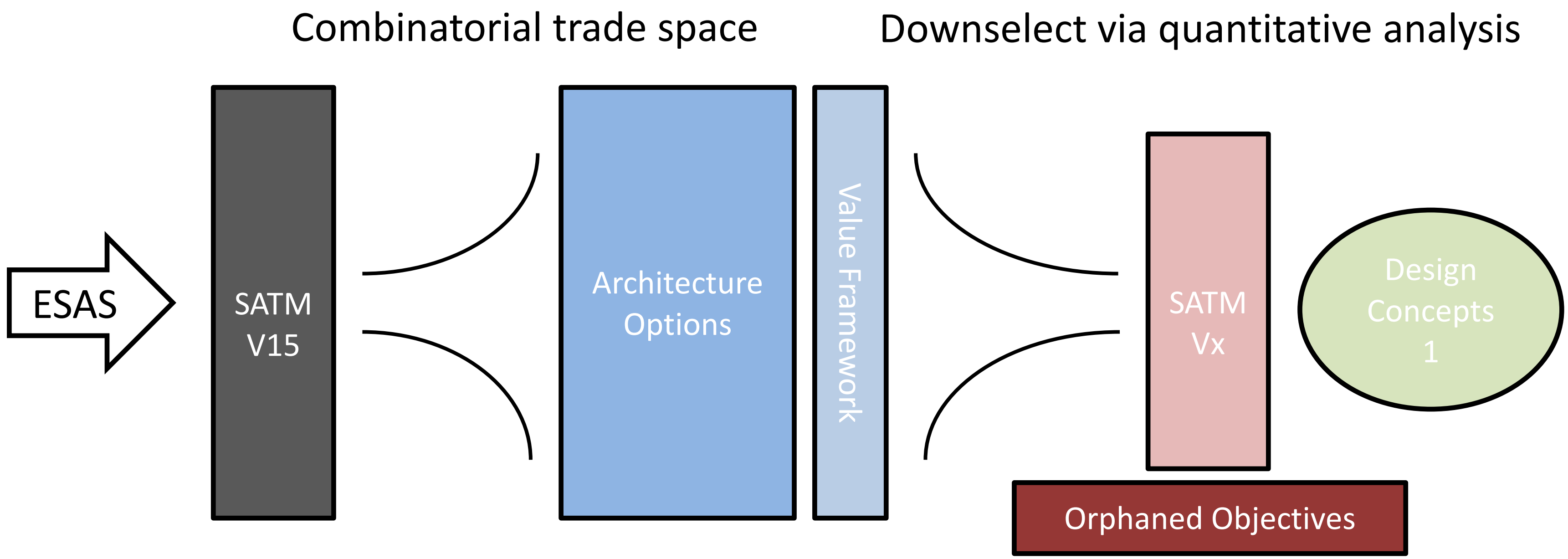
# Phase I: Expand and Explore




# Phase II: Constrain and Quantify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# Purposes of SATM in Phase I

- **Capture "Most Important" and "Very Important" measurements in the ESAS***
- **Inform trade study by identifying key classes & distinctions impacting architecture design**
- **Show driving science challenges**
- **Permit direct traceability between algorithms / products and the ESAS**
- **Inform system simulation studies**
- **Identify Applications and DO beneficiaries**

*While we are focused on the Most and Very Important Objectives given in the ESAS, we will also assess Architectures WRT the Important objectives as well as orphans, Applications requirements, etc. The Value Framework will help us quantify how well each architecture addresses the various objectives.



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# The SATM in Phase I AVOIDS:

- **Optimizing or fine-tuning measurements**
  - "VNIR vs. VSWIR" not "10 vs 15 nm sampling"
- **Preempting architecture decisions**
  - "Daily revisit" not "active pointing"
- **Assessing quantitative science yield**
  - deferred to detailed Phase 2 study of a reduced number of potential architectures
- **Expanding scope beyond TO-18 Objectives**


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# How to read the SATM

| STM for DS Targeted Observables TO-18 (Surface Biology & Geology) | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Decadal Survey Science Topics, Questions, Objectives, and Geophysical Observables | | | | | SBG Example Geophysical Variables and Capabilities | | | | | | | | | | | |
| Topic | DS Science Question | DS Science/Application Objective | Priority | DS Suggested Geophysical Parameters | Example SBG Geophysical Parameters | VSWIR Spatial | VSWIR Temporal | VSWIR Range | VSWIR Sensitivity | TIR Spatial | TIR Temporal | TIR Range | TIR Sensitivity | Notes | Enabled Applications | DO Synergies |
| **Global Hydrological Cycles and Water Resources** | **H-1**. How is the water cycle changing? Are changes in evapotranspiration and precipitation accelerating, with greater rates of evapotranspiration and thereby precipitation, and how are these changes expressed in the space-time distribution of rainfall, snowfall, evapotranspiration, and the frequency and magnitude of extremes such as | **H-1c.** Quantify rates of snow accumulation, snowmelt, ice melt, and sublimation from snow and ice worldwide at scales driven by topographic variability. | Most Important | Snow and glacier albedo and surface temperature. Spectral albedo of suxbpixel snow and glaciers at weekly intervals to an accuracy to estimate absorption of solar radiation to 10%.Ice/snow temperature to ± 1K. At spatial resolution of 30 to 100 m. | Snow and ice coverage fraction (cryosphere) | A | A | A | B | | | | | R1, R8, R12, R26 | A1, A2, A4, A5, A6 | |
| | | | | | Snow spectral albedo From Visible to Thermal (cryosphere) | A | A | A | B | A | B | B | A | R1, R8, R12, R26 | A1, A2, A4 | |
| | | | | | Snow surface temperature (cryosphere) | | | | | A | B | B | A | R4, R5, R8, R26 | A3 | |
| | **H-2**. How do anthropogenic changes in climate, land use, water use, and water storage, interact and modify the water and energy cycles locally, regionally and globally and what are the short- and long-term consequences? | **H-2a.** Quantify how changes in land use, water use, and water storage affect evapotranspiration rates, and how these in turn affect local and regional precipitation systems, groundwater recharge, temperature extremes, and carbon cycling. | Very Important | Latent heat flux. 3 (desirable) to 6 hour (useful) resolution during daytime intervals and at 1 km spatial scale with better than 10 W/m2 accuracy. Requires temperature of soil and vegetation separately at 40-100m spatial resolution, accuracy of +/- 1K, at temporal frequency to resolve the diurnal cycle. Albedo of soil and vegetation separately to an accuracy to estimate absorption of solar radiation to 10 W/m2, at weekly intervals at field scale, 30-60m spatial resolution. | VSWIR Spectral surface reflectance | B | A | A | | | | | | R2, R3, R7, R8, R14, R27,R28 | A8, A9, potentailly some E1-a applications . | D1, D2 |
| | | | | | TIR emissivity | | | | | A | B | | A | R4, R5, R8, R27 | A8, A14 | D1 |
| | | | | | Evapotranspiration rates of vegetation canopies with 10% uncertainty (multiple times of day) | | | | | B | B | B | A | R4, R5, R8, R13, R23, R27 | A7, A12, A13, A23 | A-CCP |
| | | | | | Surface temperature (multiple times of day) | | | | | A | B | B | A | R4, R5, R8, R27 | A8, A12, A13, A14 | A-CCP |
| | **H-4.** Hazards, Extremes, and Sea-level Rise. How does the water cycle interact with other Earth system processes to change the predictability and impacts of hazardous events and hazard chains (e.g., floods, wildfires, landslides, coastal loss, subsidence, droughts, human health, and ecosystem health), and how do we improve preparedness and mitigation of water-related extreme events? | **H-4a.** Monitor and understand hazard response in rugged terrain and land margins to heavy rainfall, temperature and evaporation extremes, and strong winds at multiple temporal and spatial scales. | Very Important | Magnitude and frequency of severe storms. Depth and extent of floods. Precipitation, snowmelt, water depth, and water flow in soil at time and space scales consistent with events. | See H1-c | | | | | | | | | | | |

Decadal Survey Science Questions:
General to specific
Text direct from ESAS 2018

Example geophysical measurements

Implied capabilities (VSWIR)

Implied capabilities (TIR)

Applications, Notes and References, DO Synergies

# Capability codes

**VSWIR Spatial**

| | |
|---|---|
| A | 30 m |
| B | 30 - 60 m |

**VSWIR Temporal**

| | |
|---|---|
| A | Weekly |
| B | Biweekly, 14-16 days |

**VSWIR Sensitivity**

| | |
|---|---|
| A | SNR = 400:1 VNIR/250:1 SWIR @ 25% reflectance; |
| B | 10% Absolute |

**VSWIR Range**

| | |
|---|---|
| A | 380-2500 20nm |
| B | VNIR 20nm |
| C | Multiband VNIR |

**TIR Spatial**

| | |
|---|---|
| A | 30-60 m (30-45 m volcanoes) |
| B | 60-100m |
| C | >100m |

**TIR Temporal**

| | |
|---|---|
| A | daily or sub-daily |
| B | 3-5 days |
| C | >5 days |

**TIR Sensitivity**

| | |
|---|---|
| A | <0.4K NeDT per band |
| B | <1K NeDT, or ~1.5% uncertainty in absolute emissivity |

**TIR Range***

| | |
|---|---|
| A | 4 Micron + 5 or more bands |
| B | 5 or more Bands in 8-12 um |
| C | >2 Bandsin 8-12 um |

* May eventually be specified in terms of temperature accuracy requirements.


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# SATM v15, row by row


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# Quantifying science yield

**Basic**

**Refined**

1. **Assert from experience -** "Back of Napkin" based on analogy to prior investigations, spectral/spatial coverage, etc.

2. **Retrieval uncertainty for representative observations**

3. **Retrieval uncertainty for realistic distribution of observations**

4. **Posterior uncertainty in main objective, under a realistic simulated mission (full OSSE)**



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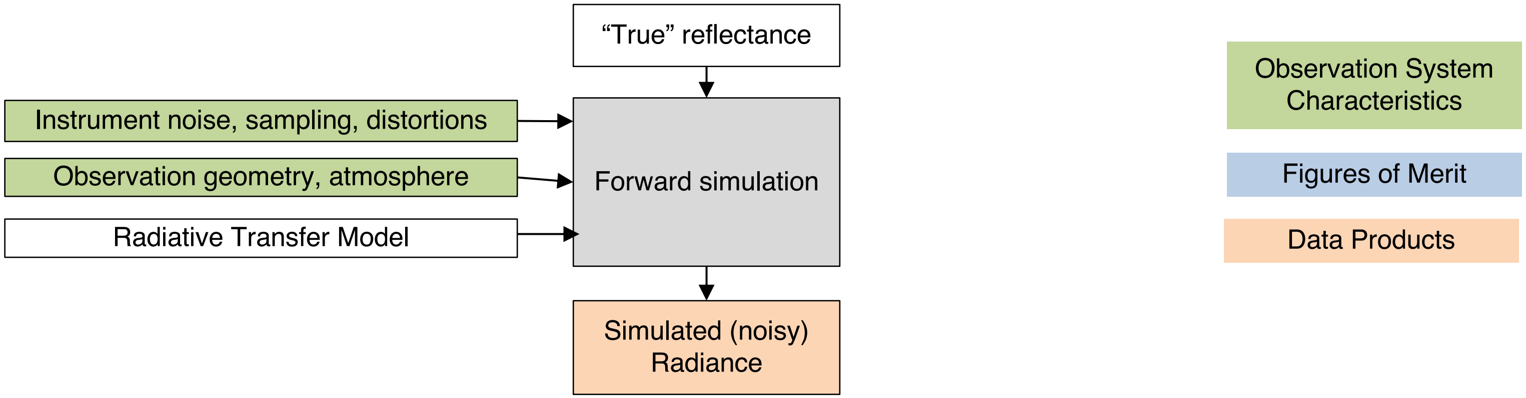
# Phase II: Quantifying science yield



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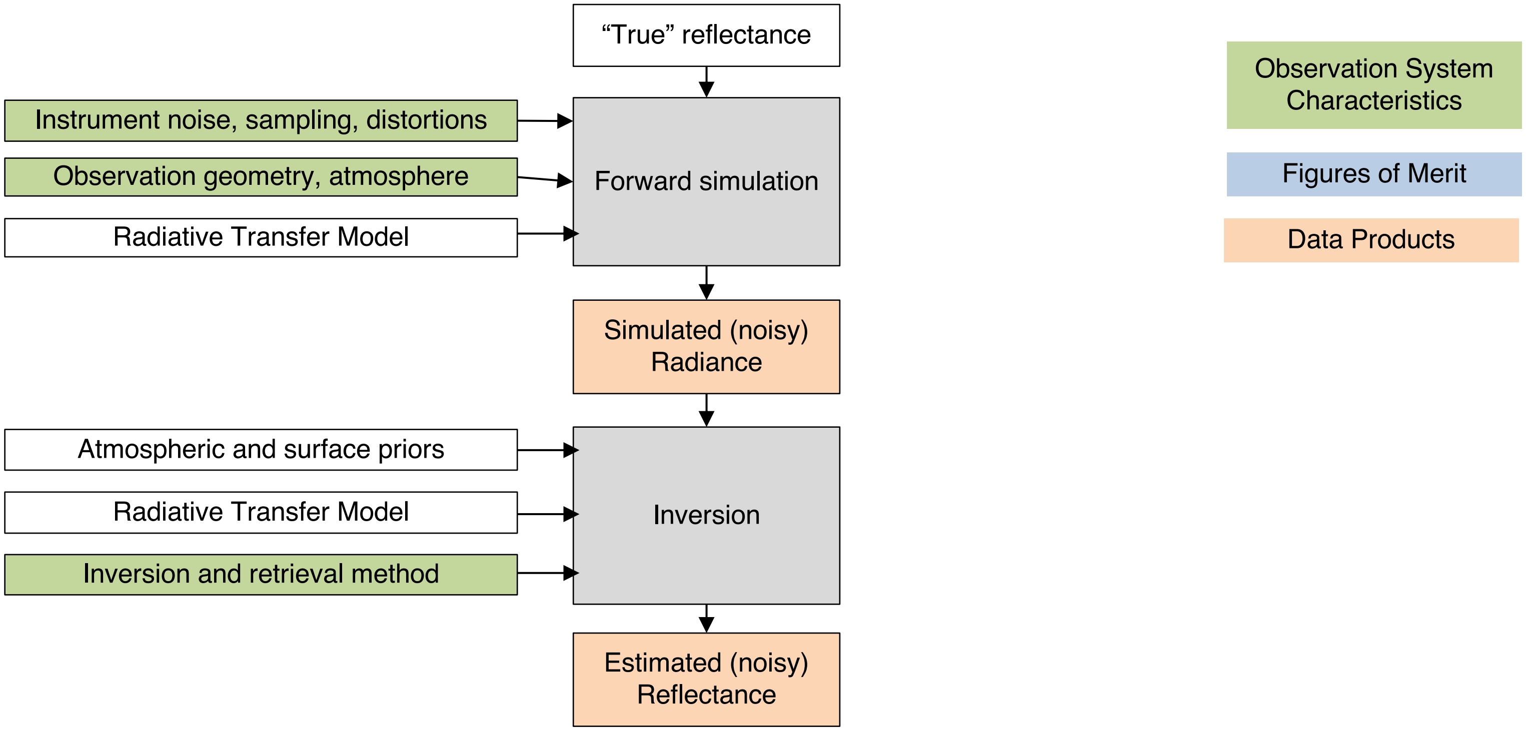




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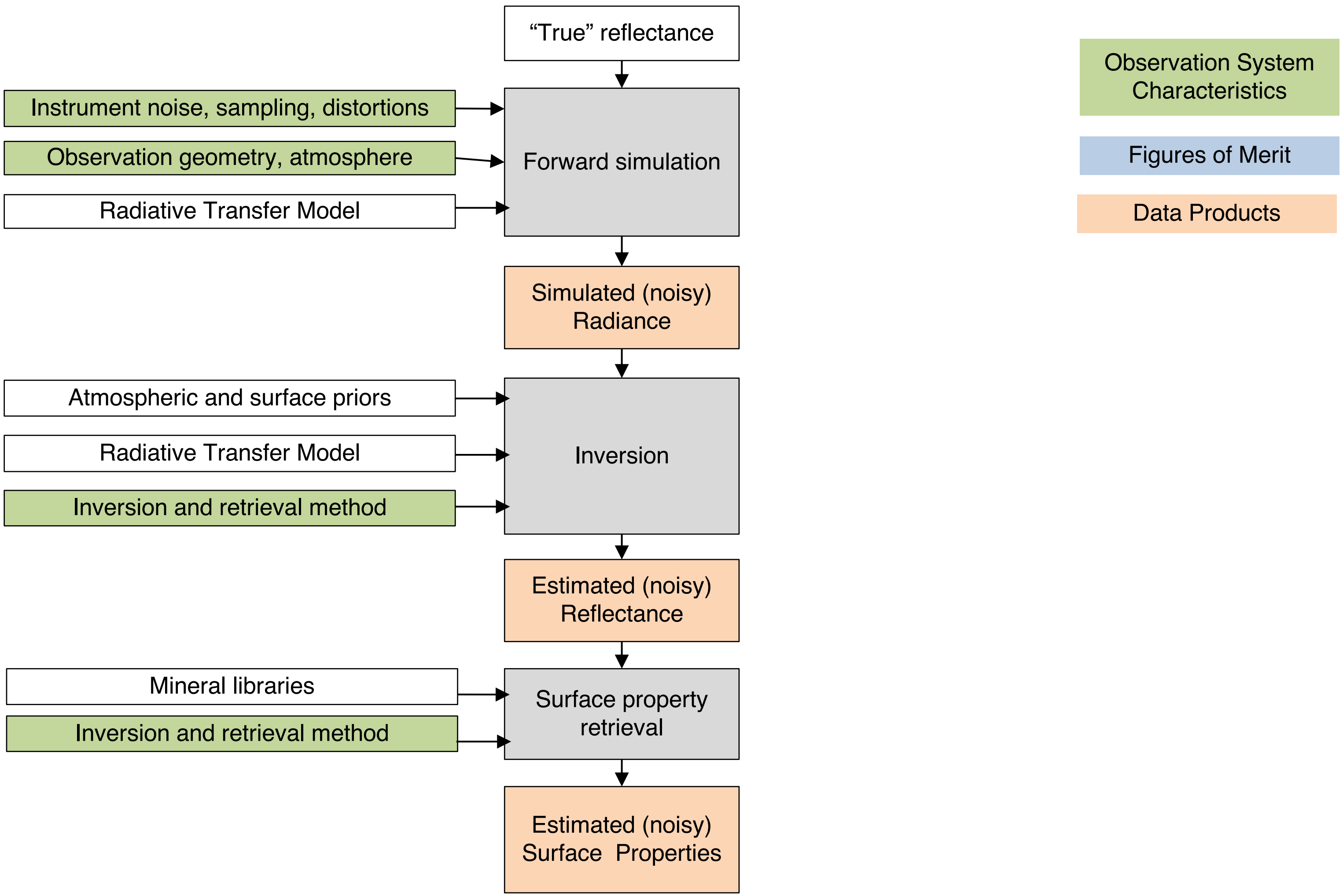



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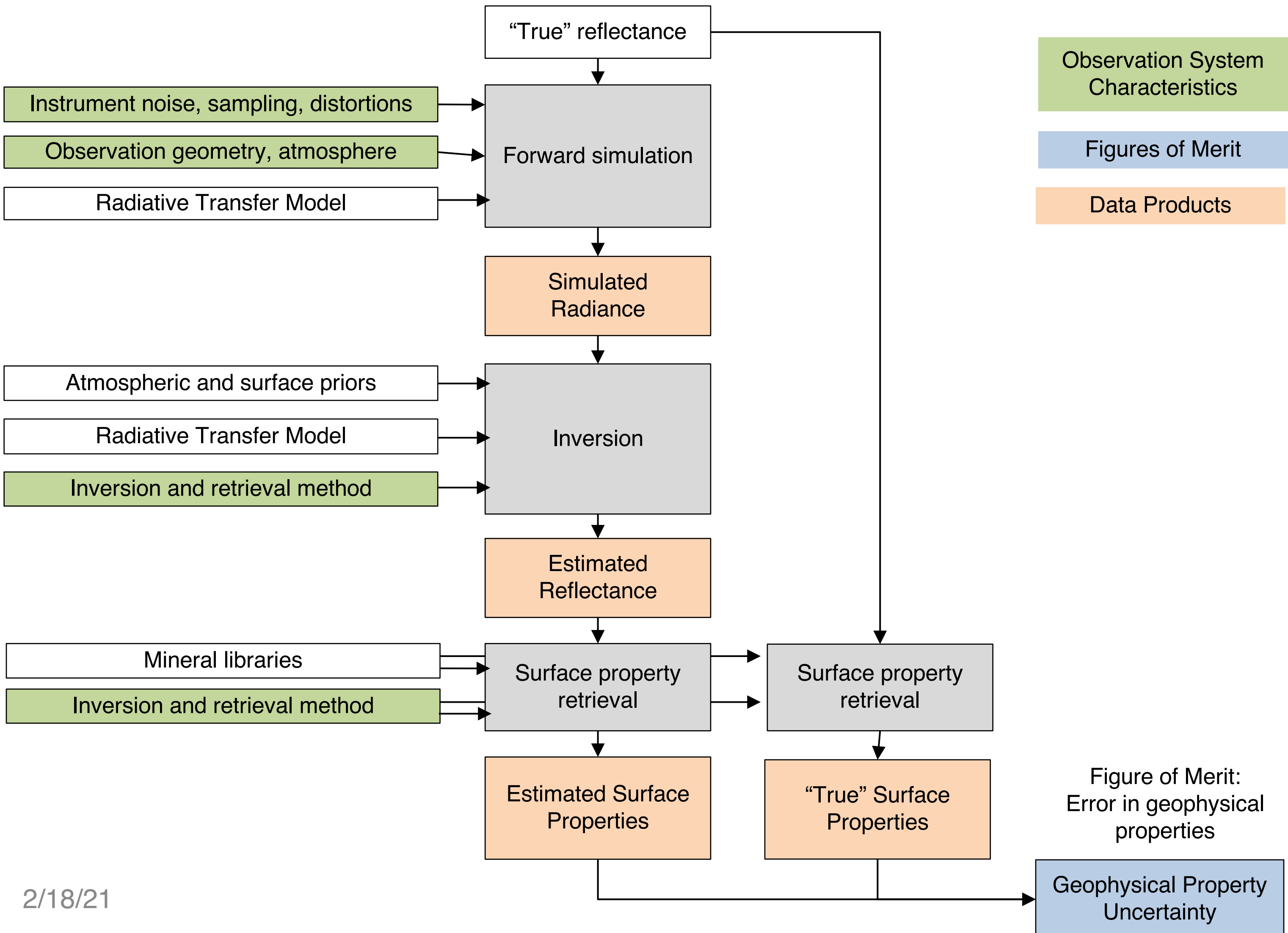

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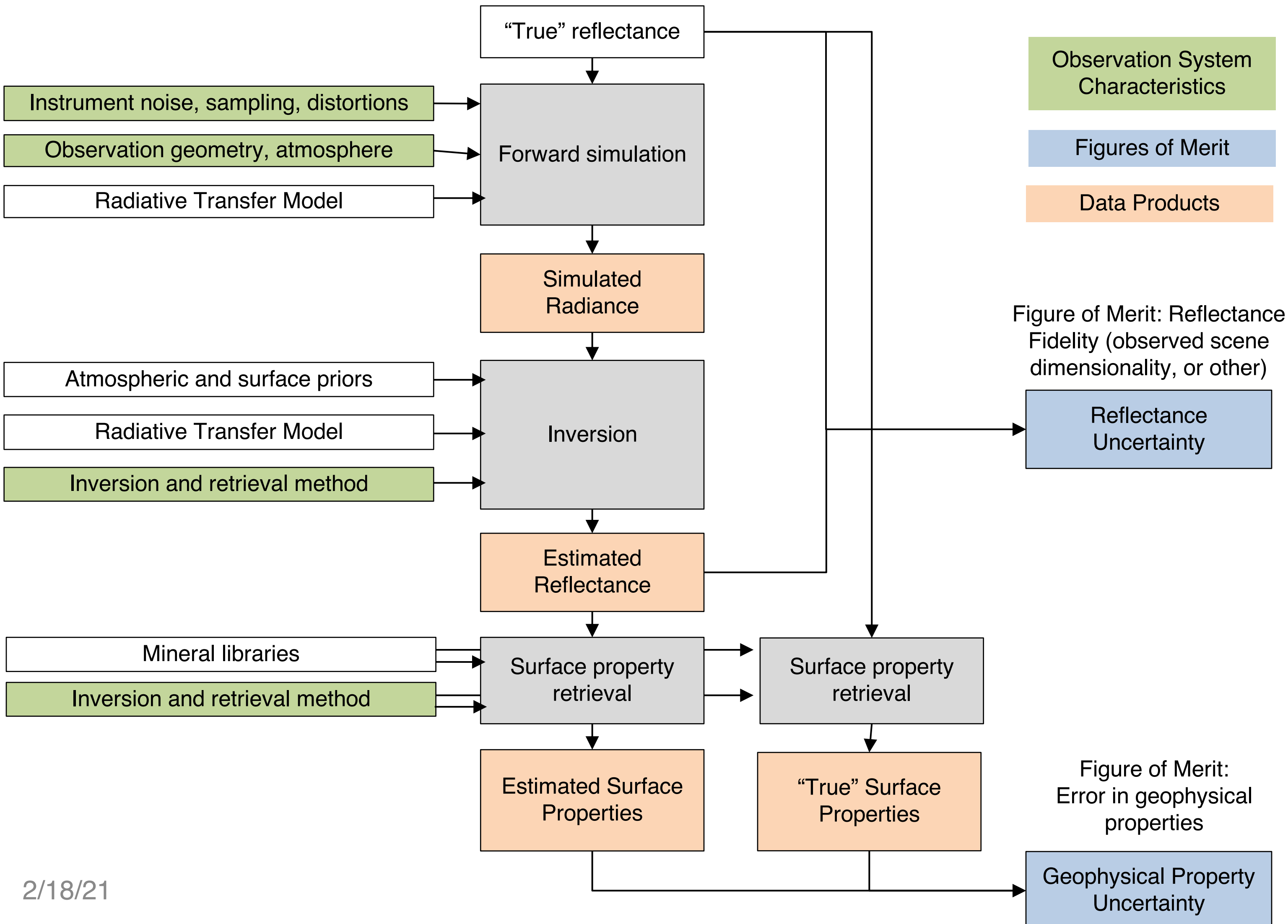




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AGU 100 ADVANCING EARTH AND SPACE SCIENCE | FALL MEETING

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# Advances toward Global Imaging Spectroscopy and Thermal Infrared Measurements

**Submit an Abstract to this Session**

A new generation of remote solar-reflected spectroscopy and thermal infrared measurement is revolutionizing terrestrial and aquatic ecology, surface geology, hydrology and land use studies.  Airborne precursors presage upcoming orbital investigations by space agencies worldwide, including International Space Station (ISS) missions like ECOSTRESS (USA, 2017), DESIS (Germany, 2018), HiSUI (Japan, 2021), and EMIT (USA, 2021), and polar orbiters such as PRISMA (Italy), EnMAP (Germany, 2020),  and FLEX (ESA, 2023), and anticipated investigations like SBG (USA) and CHIME (ESA).  We will survey progress of individual missions and ongoing preparatory research by recent imaging spectrometer and thermal IR airborne campaigns.   We will also highlight progress translating local models to address Earth system questions at regional and global scales.  Our themes include: coral reef surveys; volcano investigations; surface ecology and biodiversity studies; aquatic ecosystem and water quality monitoring; hydrology studies, including ice and snow characterization; land use studies; and more.

**https://agu.confex.com/agu/fm19/prelim.cgi/Session/75253**

**Deadline:  31 July 23:59 EDT**

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